Introductory Quantum Mechanics.

PHY520.

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Textbook:	Quantum Physics by Stephen Gasiorowicz, 2^{nd} Ed.
Web page	http://www.pa.uky.edu/ gorringe/phy520/phy520.html
Office hours:	M 11:00 - noon.
	W 11:00 - noon.

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1 Course Objectives.

The microscopic world is a very strange place. Concepts like matter waves, the fleeting non-conservation of energy and momentum, and the entangling of the measured and the measurer, do not make common sense. It is not surprising therefore that Quantum Mechanics, the theory of the microscopic world, is a difficult and strange theory.

This course is an introduction to Quantum Mechanics. The goals are to learn the rules of Quantum Mechanics, to learn how to do calculations in Quantum Mechanics, and to discuss the concepts of Quantum Mechanics. In this way you will discover for yourself that the microscopic world is a very strange place.

2 Course Prerequisites.

The prerequisites for this course are two semesters of general university physics, calculus I through IV, and PHY361 principles of modern physics.

3 Course Structure.

PHY520 meets M–W–F from 10:00 to 10:50 in room CP367. In the following pages you can find the topics and textbook sections to be covered in each class. Before each class read the relevant sections in the textbook.

4 Course Grading.

4 Your final grade will be based on your homework, two tests, and a cumulative final. The proportions are homework 20%, each test 20%, and final 40%. Each Wednesday 1–2 homework

problems will be collected from the 4–5 homework problems assigned the previous week. Your ten best homework scores will be used to determine your overall homework grade. Late homework is not accepted.

5 Day-by-day guide to topics.

Date	Topic	Ch.pgs
W 28 Aug	The quantum and Planck's constant.	1.1–9
F 30 Aug	The quantum and Bohr's atom.	1.15-21
M 02 Sep	Labor Day	
W 04 Sep	Wave–particle duality – the theory of wave packets.	2.27–31
F 06 Sep	Wave–particle duality – the concept of uncertainty.	2.33–38
M 09 Sep	Introducing the Schrodinger equation – wavefunctions and the probability density and probability current.	3.41–45
W 11 Sep	Introducing the Schrodinger equation – operators and their expectation values and commutation relations.	3.45–51
F 13 Sep	Introducing the Schrodinger equation – its an eigenfunction–eigenvalue equation.	4.54–57
M 16 Sep	A quantum particle in a one–dimensional box and its eigenfunctions and eigenvalues.	4.58–60
W 18 Sep	A quantum particle in a one–dimensional box – more subtle things like superposition, degeneracy and symmetry.	4.60–70
F 20 Sep	A one–dimensional potential barrier – the weird idea of tunneling.	5.75–93
M 23 Sep	A one–dimensional potential well – bound states and scattering states.	5,75–93
W 25 Sep	A one–dimensional harmonic operator – some math, some physics and some pictures.	5.103–108
F 27 Sep	Getting formal – drawing an analogy between quantum space and ordinary space.	6.117–124

Date	Topic	Ch.pgs
M 30 Sep	Getting formal – observables and observations, commutation relations and expectation values.	6.124–128
W 02 Oct	An old problem and a new method – the 1–D harmonic operator and creation, annihilation and number operators.	7.130–139
F 04 Oct	An old problem and a new method – the 1–D harmonic operator and creation, annihilation and number operators.	7.130–139
M 07 Oct	**Test One - chapters one to seven.**	
W 09 Oct	Review of Test One.	
F 11 Oct	Two–particle systems.	8.145–150
M 14 Oct	Identical–particle systems.	8.150–157
W 16 Oct	3–dimensional Schrodinger equation in cartesian coordinates – a particle in a cubic box	9.160–164
F 18 Oct	3–dimensional Schrodinger equation in cartesian coordinates – why stars don't collapse (or why stars do collapse).	9.164–168
M 21 Oct	Symmetry principles and conservation laws – central potentials, rotational symmetry and angular momentum.	10.168–172
W 23 Oct	What we can and cannot know about angular momentum - the operators $\mathbf{L}^2$ and $\mathbf{L}_z$.	10.172–175
F 25 Oct	3–dimensional Schrodinger equation in in spherical coordinates - the angular bit.	10.172–175
M 28 Oct	3–dimensional Schrodinger equation in in spherical coordinates - the radial bit.	10.175–180

Date	Topic	Ch.pgs
W 30 Oct	3–dimensional Schrodinger equation in in spherical coordinates - a particle in a spherical box.	10.180–185
F 01 Nov	More on angular momentum – $\mathbf{L}^2$ and $\mathbf{L}_z$ and their eigenfunctions and eigenvalues.	11.188–191
M 04 Nov	More on angular momentum – the idea and the of the raising and lowering operators.	11.192–195
W 06 Nov	More on angular momentum – the spherical harmonics mathematically, physically and pictorially.	11.195–197
F 08 Nov	The hydrogen atom – how to solve the the Schrodinger equation.	12.203–213
M 11 Nov	The hydrogen atom – what do its energy eigenvalues and eigenfunctions look like?	12.203–213
W 13 Nov	The hydrogen atom – exploring superposition degeneracy, symmetry via problem solving.	12.203–213
F 15 Nov	**Test Two - chapters eight to twelve.**	
M 18 Nov	Review of Test Two.	
W 20 Nov	Even more on angular momentum – representing $\mathbf{L}^2$ and $\mathbf{L}_z$ with matrices rather than differentials.	13.236–241
F 22 Nov	Even more on angular momentum – the idea of of spin angular momentum as well as orbital angular momentum.	13.241–244
M 25 Nov	Even more on angular momentum – practice problem solving in matrix mechanics rather wave mechanics.	13.236–244
W 27 Nov	Thanksgiving Holiday	
F 29 Nov	Thanksgiving Holiday	

Date	Topic	Ch.pgs
M 02 Dec	The ammonia molecule and more matrix mechanics.	see handout
W 04 Dec	The ammonia maser and more matrix mechanics.	see handout
F 06 Dec	Adding angular momenta – the case of adding two spins.	15.253–258
M 09 Dec	Adding angular momenta – the case of adding orbital and spin angular momenta.	15.258–259
W 11 Dec	Adding angular momenta – the general rules and the Clebsch–Gordan coefficients.	15.259–265
F 13 Dec	Adding angular momenta – practice problem solving in the addition of angular momenta.	15.253–265
M Dec 16	Final Exam. 8am to 10am in CP367.	